VLBA PROPOSAL COVERSHEET

rcvd:

DEADLINES: 1st of Feb., June, Oct.

(1) Date Prepared: January 31, 2008

(2) Title of Proposal: Search for calibrators in the deep south

(3) AUTHORS (Add * for new location)	INSTITUTION	E-mail	Students Only G/U	For Thesis?	Ph.D. Year
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(4) Related previous or current VLBI proposal(s): BB023, BF071, BP110, BP118, BK125, BP133 ◯ Resubmission

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(7) Scientific Category: ⊗ astrometry & geodesy ◯ galactic ◯ extragalactic ◯ other:
Rapid Response Science: ◯ Known Transient ◯ Exploratory ◯ Target of Opportunity

(8) Wavelength(s) requested (those not available on the global network are indicated with a small circle):
◯ 90cm ◯ 50cm ◯ 30cm ◯ 21cm ◯ 18cm ◯ 13cm ◯ 6cm ◯ 5cm ◯ 3.6cm ⊗ 3.6/13cm
◯ 2cm ◯ 1.3cm ◯ 7mm ◯ 3mm
◯ Global Network standard bands ◯ Special frequencies: _____

(9) Recording format: ⊗ Default continuum setup (VLBA only), ◯ VLBA/MkIV, ◯ MkIII: Mode _____
Bandwidth per BaseBand channel: _____
Aggregate bit rate: 256 (8 BB channels at 16 MSamples/sec of ◯ 1 bit, ⊗ 2 bit)

(10) ◯ Multi-epoch observation: _____ epochs of _____ hours each, separated by _____

(11) Network	Requested antennas	Total time requested
EVN & MERLIN		
VLBA	ALL	3×24 hours
other NRAO		
Non-VLBI Instruments		

(12) ABSTRACT (Do not write outside this space. Please type)

We request three 24 hour blocks of VLBA observing time for a search of new calibrators in the declination zone $[-50°, -25°]$ that are needed for the southern VLBI network LBA, as well as for the ALMA, and the SKA pathfinders in Australia and South Africa. This project compliments efforts of the Australian VLBI group for an increase the number of calibrators in the southern hemisphere.

We propose to observe 500 new sources in the declination zone where the density of calibrators was significantly less than on average, in order to derive their position with milliarcsec accuracy and to get estimates of the correlated flux density and compactness. The purpose of this project is to extend the VLBA Calibrator list to the southern sky for benefits of the user community.

Scheduler use only
(8/03)

(13) Observation type: ⊗ Interferometry, ◯ Spectroscopy, ◯ Pulsar, ◯ Phase referencing

(14) Proposal is ⊗ Suitable for dynamic scheduling.

(15) Polarization: ⊗ Single Polarization ◯ Dual Circular Polarization
Global network standard for single polarization is LCP for all λs except 13cm (RCP) and 3.6cm (RCP).

(16) Tape usage (Show <recording time>/<total time>): _____

(17) Assistance required:
Observation Setup: ◯ Consultation, ◯ Extensive help, ◯ Observe file preparation
Postprocessing: ◯ Consultation, ◯ Extensive help, ◯ Calibration service

(18) Processor: ⊗ Socorro, ◯ JIVE, ◯ Haystack, ◯ Bonn, ◯ Washington, ◯ Other_____
Special processing: ◯ XPol, ◯ Pulsar gate, ◯ Multiple Fields: _____
Averaging time: 0.5 sec Spectral channels per baseband channel: 64
◯ Other special processing: _____

(19) Postprocessing Location: GSFC, MPIfR, NRAO-CV

(20) Source list: ◯ J2000 ◯ B1950
If more than 4 sources, please attach list. If more than 30, give only selection criteria and GST range(s)

	Source 1	Source 2	Source 3	Source 4
Name(s)	ALL SKY			
RA (hh mm)	0–24h			
Dec (dd.d)	–50d to +88d			
GST range (Europe)				
GST range (US)	0–24h			
GST range (Other)				
Band(s)	S/X			
Flux density (Total, Jy)	>50 mJy			
Flux density (correlated, mJy)	>50 mJy			
RMS needed (mJy/beam)	3–5 mJy			
Peak/RMS needed	>100:1			

(21) Preferred VLBI session or range of dates for scheduling, and why:
Three 24 hour sessions.

(22) Dates which are NOT acceptable, and why:

(23) Attach a self-contained scientific justification, not in excess of 1000 words.
Preprints or reprints will not be forwarded to the referees.

Information about the capabilities of the VLBA may be found on the World Wide Web by starting at the NRAO home page, http://www.nrao.edu, and selecting the VLBA from "Sites and Telescopes."

A brief summary of the capabilities of the EVN antennas is given in the EVN STATUS TABLE in the EVN USER GUIDE, which may be found at http://www.evlbi.org/user_guide/user_guide.html.

Please include the full postal addresses for first-time users or for those that have moved (if not contact author).

Search for calibrators in the deep south

1 Summary

We request three 24 hour blocks of VLBA observing time for a search of new calibrators in the declination zone [−50°, −25°] that are needed for the southern VLBI network LBA, as well as the ALMA, and the prototype of the SKA at South Africa. This project compliments efforts of the Australian VLBI group for an increase the number of calibrators in the southern hemisphere.

2 Previous Observations

VLBA Observing programs BB023, BF071, BP110, BP118, BK125, and BP133 were designed to expand the list of calibrator sources suitable for phase referencing, for geodetic observations, and for space navigation. The need for separations of no more than several degrees between the calibrator and target source for successful phase referencing, e.g., [1], requires a list of several thousand calibrator sources. Twenty four VLBA Calibrator observing sessions, each of 24 hours, were made between 1994 and 2007.

The results from the above observations were published, [2], [3], [4], [5], [6], [7] and made available on the Web at `http://www.vlba.nrao.edu/astro/calib, http://vlbi.gsfc.nasa.gov/astro, http://vlbi.gsfc.nasa.gov/vcs/`. In the web sites, all sources within a specified distance from a selected target position can be found, and images and visibility plots for each potential calibrator can be scrutinized. Owing to VLBA Calibrator Survey observations, the number of calibrators in the pool surpassed 3000 by 2007.

3 Proposed Observations

However, the number of calibrators in declination zones below −30° drops by a factor of 4 as shown in Figure 1 and table 1. The probability of not finding a calibrator within 3° from the target is only 6% in northern hemisphere, but increases to 25% at the declination zone [−30°, −40°] and 58% at declinations below −40°.

Figure 1. Calibrator source density per steradian as a function in various declination zones.

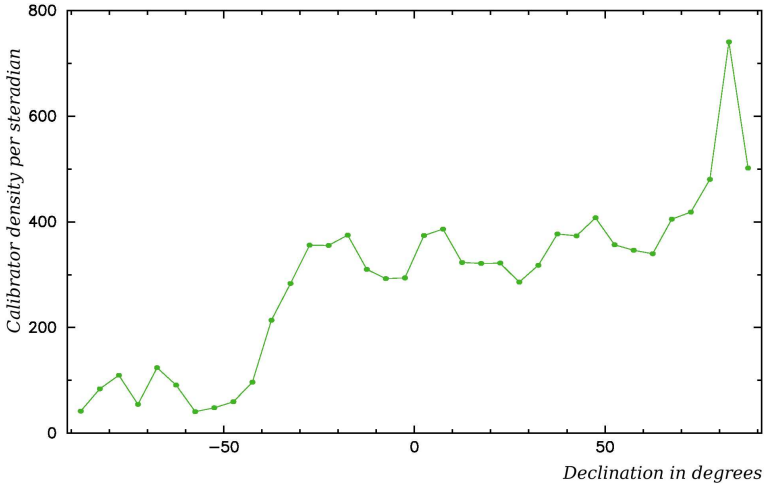

Table 1. Probability to find a calibrator in the disk of the specified radius at any given direction in various declination zones.

Zone	2°	3°	4°
−20°, +90°	70.2%	94.1%	99.5%
−30°, −20°	64.6%	90.7%	98.5%
−40°, −30°	45.1%	75.1%	91.6%
−52°, −40°	21.5%	42.3%	61.2%
−90°, −52°	21.3%	41.4%	61.1%

There is a need to extend the pool of calibrators further to the southern hemisphere:

1. VLBI observations with the southern VLBI network LBA need calibrators for phase-referencing observations of weak sources. One of the important applications will be follow-up observations of γ-ray sources that will be detected with the GLAST mission. Many of them will be weak at radio frequencies and will require a nearby phase calibrator for detection.

2. ALMA, as well as the SKA precursors in Australia and South Africa, needs 50–100 strong compact calibrators over the sky. These primary calibrators will be used for determination of ALMA antenna positions. These primary calibrators will be used for the determination of ALMA antenna positions (and similar astrometric calibrations for SKA) to the specified accuracy. the positional accuracy needed for the calibrators is about 1-mas level.

3. Since it is difficult to predict which sources observed at S/X band will be sufficiently bright or compact 300 GHz, the frequency that ALMA to be used for most accurate astrometric observations, or at < 1.6 GHz for the SKA, the number of candidate primary calibrators found at S/X band should be at least 200.

4. ALMA and SKA will need several thousands secondary calibrator sources for the separation of a target to a secondary calibrator to be less than 2–3°. The grid of secondary calibrator will be also used for differential astrometry,and their positions should be known with accuracy better of a few mas in order to obtain accurate absolute positions and to remove contribution of second order phase effects. Thus, the position of these secondary calibrators must be accurately tied to the global set of primary calibrators already cataloged.

Recognizing these challenges, a program for a search of calibrators with the LBA in the declination zone [−90°, −50°] has been submitted to the LBA, and the first experiment is scheduled at 2008.02.05[1]. Since the LBA currently observes only 14 days per year, extension of calibrator search with the LBA to declinations above −50° is problematic, because it would take a disproportionally large share of resources.

In order to match these efforts, we propose to observe candidate flat-spectrum sources in the declination zone [−50°, −25°] with the VLBA. This will require to observe at low elevation angles, down to 5°. We will use the same elevation angle limit as in routine geodetic experiments. The declination accuracy will be relatively poor, but the compactness of the source should be well determined.

The list of 500 bright flat spectrum candidate sources is selected on the basis of the preliminary version of the AT20G catalogue[2].

4 Technical details

Observations should be done in three 24 hour runs, as is usually done for absolute astrometry observations, in order to minimize systematic errors. We propose to observe in the same manner as previously, dual S/X band with wide spanned bandwidth, two scans of 3 minutes long per source and 10 minute bursts of troposphere calibrators over the sky every 1.5–2 hours. Since the entire array will not see low declination sources, different source will be observed at sub-arrays, as it usually done in geodesy mode. Southern stations MK, SC, KP, FD, and PT will observe sources with declinations below −40°, while northern stations at the same time will observe sources with declinations above −40°. The third 24 run will be scheduled after preliminary results of first two runs will be known. That run will focus on re-observing sources that were missed due to failures, bad weather, etc., and on observing sources in the declination zone [−25°, −35°]. We request 256 Mbps recording rate because we have to observe at low elevation angles that limits integration time. From the other hand, we need to reach the baseline SNR at least 20 in order to determine source coordinates with milliarcsec accuracy at a limited number of antennas. Considering that the VLBA at S/X has sensitivity of 4–5 mJy for 3 minutes of integration time at 256 Mbps at low elevations, this allows us to observe sources with the expected correlated flux density at a level of 100 mJy.

The calibration and imaging will be made by using packages AIPS and DIFMAP. We do not expect maps to be of great quality due to a very poor *uv*-coverage, but properly calibrated visibilities will provide valuable estimates of correlated flux densities that are needed for scheduling phase calibrator observations. Positions will be determined with Calc/Solve. Both, positions and maps in FITS format, will be included in the VLBA Calibrator list and become available on the Web to the community within 30 days upon completion of correlation. Based on our experience of analyzing low elevation data, we expect the position accuracy of 2–5 mas, a factor of 2 worse than in previous VCS observations.

[1] http://vlbi.gsfc.nasa.gov/lcs/

[2] http://www.atnf.csiro.au/research/AT20G

References

[1] Beasley, A. J., in *Very Long Baseline Interferometry and the VLBA*, 1995 ASPCS, 82, 327

[2] Beasley, A. J., Gordon, D., Peck, A. B., Petrov, L., MacMillan, D. S., Fomalont, E. B., & Ma, C. 2002, ApJS, 141, 13

[3] Fomalont, E. B., Petrov, L., MacMillan, D. S., Gordon, D., & Ma, C., 2003, AJ, 126 (N5), 2562, 2003.

[4] Petrov, L, Kovalev, Y. Y., Fomalont E., Gordon D., AJ, 129, 1163, 2005.

[5] Petrov, L, Kovalev, Y. Y., Fomalont E., Gordon D., AJ, 131, 1872, 2006.

[6] Kovalev, Y. Y., Petrov, L, Fomalont E., Gordon D., AJ, 133, 1236, 2007.

[7] Petrov, L., Kovalev, Y. Y., Fomalont E., Gordon D., 2008, submitted to AJ. `http://arxiv.org/abs/astro-ph/0801.3895`